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RUEGER,G.M. Pacific Gas & Electric Co.
RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 94-006-00:on 941001,SG feedwater ring degradation occurred due to flow accelerated corrosion.Through-wall holes near feedwater ring bottom nozzle plugs of SG 2-4 weld repaired.W/950120 ltr.

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Gregory M. Rueger
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General Manager
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January 20, 1995

PG&E Letter DCL-95-012

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
Licensee Event Report 2-94-006-00
Steam Generator Feedwater Ring Degradation Due to Flow Accelerated Corrosion

Gentlemen:

Pursuant to Item 19 of Supplement 1 to NUREG-1022, PG&E is submitting the enclosed voluntary licensee event report regarding degradation in the steam generator feedwater distribution header due to flow accelerated corrosion.

This condition did not affect the health and safety of the public.

Sincerely,

Gregory M. Rueger

cc: Edward T. Baker
L. J. Callan
Kenneth E. Perkins
Michael D. Tschiltz
Diablo Distribution
INPO

Enclosure

6770S/KWR/2246

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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Diablo Canyon Unit 2	0 5 0 0 0 3 2 3	1 OF 6

TITLE (4) Steam Generator Feedwater Ring Degradation Due to Flow Accelerated Corrosion

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MON	DAY	YR	YR	SEQUENTIAL NUMBER	REVISION NUMBER	MON	DAY	YR	FACILITY NAMES	DOCKET NUMBER (S)
10	01	94	94	- 0 0 6 -	0 0	01	20	95	Diablo Canyon Unit 1	0 5 0 0 0 2 7 5
										0 5 0 0 0

OPERATING MODE (9)	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (11)
6	_____ 10 CFR _____
POWER LEVEL (10) 0 0 0	x OTHER - Voluntary
	(Specify in Abstract below and in text, NRC Form 366A)

LICENSEE CONTACT FOR THIS LER (12)

	TELEPHONE NUMBER
	AREA CODE
David P. Sisk - Senior Regulatory Compliance Engineer	805 545-4420

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
[ ] YES (If yes, complete EXPECTED SUBMISSION DATE)	[X] NO				

ABSTRACT (16)

On October 1, 1994, with Unit 2 in Mode 6 (Refueling), PG&E discovered steam generator feedwater ring degradation in the form of erosion and through-wall holes in the plugs, welds, and base metal at the location of the original feedwater bottom outlet nozzles in steam generator 2-4.

The cause of the holes appears to be flow accelerated corrosion. All of the holes are located downstream of the hot leg reducer in the area of highest velocity, swirl, and turbulent flow characteristics. All of the holes are on the downstream side of the adjacent bottom nozzle plug.

As a corrective action, the through-wall holes discovered near the feedwater ring bottom nozzle plugs of steam generator 2-4 were weld repaired. The feedwater rings for Unit 1 steam generators will be inspected during the next refueling outage. The change in secondary plant chemistry to a higher PH using ethanolamine instead of ammonia should reduce the flow accelerated corrosion rate.

I. Plant Conditions

Units 1 and 2 have been in various modes and at various power levels with the conditions described below.

II. Description of Problem

A. Summary

On October 1, 1994, with Unit 2 in Mode 6 (Refueling), steam generator (SB)(SG) feedwater ring (SJ)(FDR)(DIF) degradation was discovered in the form of erosion and through-wall holes in the plugs, welds, and base metal at the location of the original feedwater bottom outlet nozzles (SJ)(NZL).

B. Background

The steam generator provides a pressure boundary and heat removal for the reactor coolant system. Originally the flow entered the SG via holes drilled in the bottom of the feedwater ring. The present design, implemented during the initial refueling outages for both units, is for feedwater outlet through the top of the feedwater ring and then directed downward via a J-shaped tube (SJ)(WHA). This design was implemented when potential water hammer concerns were identified. The J-tubes themselves are not pressure retaining components. The steam generator feedwater ring and J-tubes act as flow distributors for the feedwater flow into the steam generator. When the J-tube design change was implemented, the original feedwater ring outlet nozzles were plugged with 3/4-inch carbon steel, tapered plugs using fillet welds.

C. Event Description

During the Unit 1 sixth refueling outage (1R6), as part of a vendor recommended ten-year inspection of the J-tubes, a limited feedwater ring inspection was performed using both visual and ultrasonic testing methods. Some flow accelerated corrosion was noted on the inside of the feedwater ring in the area surrounding some of the J-tubes and on some areas of the steam separator riser barrels (SB)(SEP), but no flow accelerated corrosion was noted in the plug areas.

During the Unit 2 sixth refueling outage, a similar but more extensive inspection was performed for the Unit 2 steam generators. During the inspection of the steam generator 2-4 feedwater ring, several through-wall holes were found in some of the plugs, plug welds, and adjacent base metal in the bottom of the

feedwater ring. The through-wall holes are located on the downstream side of the hot leg side reducer, between J-tube numbers 2 and 5. The holes are on the downstream side of the bottom nozzle plugs.

The plugs were installed to plug the bottom outlet nozzles during the first refueling outage, when the J-tube design change was implemented. The plugs are 3/4-inch carbon steel tapered plugs with carbon steel welds.

The through-wall holes in the steam generator 2-4 feedwater ring have been weld repaired.

The other three Unit 2 steam generators have also been inspected and no holes or significant plug degradation were detected.

D. Inoperable Structures, Components, or Systems that Contributed to the Event

None.

E. Dates and Approximate Times for Major Occurrences

1. October 1, 1994: Event Date/Discovery Date: Examination of the feedwater ring of steam generator 2-4 revealed through-wall holes adjacent to the plugs on the bottom of the feedwater ring.

F. Other Systems or Secondary Functions Affected

None.

G. Method of Discovery

During the performance of inspection of the steam generator 2-4 feedwater ring, Utility personnel, identified the feedwater ring degradation.

H. Operator Actions

None required.

I. Safety System Responses

None required.

III. Cause of the Problem

A. Immediate Cause

Through-wall holes in the plugs, welds, and base metal at the bottom of the steam generator feedwater ring were discovered during inspection of steam generator 2-4.

B. Root Cause

The origin of the holes appears to be flow accelerated corrosion, similar to the degradation observed around the entrance to some of the J-tube nozzles. All of the through-wall holes found have been located on the downstream side of the hot leg side reducer which is downstream of the feedwater ring inlet tee. This area has the highest velocity, swirl, and turbulent flow characteristics. All of the holes are on the downstream side of the adjacent bottom nozzle plug.

IV. Analysis of the Event

The feedwater ring in the steam generator distributes the feedwater around the U-tubes to help achieve optimum thermal performance. Changes to this performance could result in increased moisture carryover to the turbines. Although the feedwater ring distributes safety-related auxiliary feedwater, it does not serve a pressure boundary function. The feedwater ring itself has been designed to prevent initiation of a water hammer in the feedwater system.

The feedwater distribution function of the feedwater ring would not be significantly altered by the small amount of flow bypassing the 34 J-tubes per steam generator. The noted holes represent an insignificant fraction of the total flow area provided by the J-tubes. The effect on overall feedwater ring flow distribution is accordingly negligible. The additional flow stream through the holes would most likely be on the hot leg side of the steam generator, which would tend to keep the flow distribution oriented toward providing low moisture carryover.

The small jet stream created by flow through the bottom hole would be no different than the original steam generator design. It would, therefore, be an acceptable flow path and would not cause degradation of other steam generator internal components.

The original feedwater ring bottom nozzles drained the feedwater ring whenever feed flow was lost, causing it to refill with steam. A mechanism for water hammer was postulated, in which the subsequent reintroduction of cold feed flow would trap

the less dense steam in the top of the feedwater ring and cause rapid condensation. The sudden pressure reduction from the condensation would rapidly accelerate the water into the void space, resulting in a water hammer when the void was filled. As part of the J-tube design modification, the bottom nozzles were plugged to inhibit draining of the feedwater ring on a loss of feedwater flow. Top-mounted J-tubes were installed to serve the feedwater distribution function, and to provide top vent paths for the steam to escape.

The susceptibility of the J-tube design to the postulated water hammer was investigated in a 1977 test conducted by PG&E. In this test the feedwater piping was voided to a much greater extent than that for which a water hammer was predicted, yet there were no indications of water hammer. It was concluded, based on the test results, that the DCPP feedwater ring with the original bottom draining and present J-tube configurations were not susceptible to a significant water hammer event, as originally postulated, resulting from feedwater ring drainage and voiding.

Video tapes and photographs of the steam generator 2-4 bottom plug degradation were examined to assess the potential for the degraded plugs to pose a loose parts hazard. The flow accelerated corrosion is not uniform around the plugs ; the corrosion tends to be only on one side of each plug. It is judged that the substantial base metal and weld metal material remaining will prevent the Unit 1 nozzle plugs from becoming loose parts during the next cycle of operation for Unit 1. The small pressure difference between the feedwater ring and the steam generator results in very low stress on the remaining plug material

Thus, the health and safety of the public were not affected by the as-found condition.

V. Corrective Actions

A. Immediate Corrective Actions

The through-wall holes discovered near the feedwater ring bottom nozzle plugs of steam generator 2-4 were weld repaired.

B. Corrective Actions to Prevent Recurrence

1. The feedwater rings for Unit 1 will be inspected during the next refueling outage.

2. The change in secondary plant chemistry to a higher pH using ethanolamine (ETA) instead of ammonia should reduce the flow accelerated corrosion rate.

VI. Additional Information

A. Failed Components

None.

B. Previous LERs on Similar Problems

None.